Title of Project: Synthesis and Characterization of Metal Oxide based Nanocomposite Materials
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Summary

Nanotechnology is an emerging field that covers a wide range of technologies which are presently under development in nanoscale. It plays a major role in the development of innovative methods to synthesize new materials, to substitute existing production equipment and to reformulate new materials and chemicals with improved performance resulting in less consumption of energy and materials and reduced harm to the environment as well as environmental remediation. Although, reduced consumption of energy and materials benefits the environment, nanotechnology will give possibilities to remediate problems associated with the existing processes in a more sustainable way. Environmental applications of nanotechnology address the development of solutions to the existing environmental problems, preventive measures for future problems resulting from the interactions of energy and materials with the environment and any possible risks that may be posed by nanotechnology itself.

Keeping all these facts in mind we have synthesize and characterizethree different nanomaterials namely, ZnO nanomaterial, polyaniline composites and cobalt substituted nickel nano ferrites and studied the environmental applications of these materials.

ZnO nanoparticles has been synthesized by sol-gel method using very easy, cheap and convenient process. From X-ray diffraction analysis it is clear that all ZnO particles are in hexagonal wurtzite crystal structure. TEM studies showed that the particle size of zinc oxide is 10 nm. The absorption edge shifts to shorter wavelengths due to decrease in the band gap energy. FTIR spectrum shows confirmation of ZnO product. The photocatalytic activity of the ZnO nanomaterial have been used for degradation of methyl orange and phenol red dye solution. Photocatalytic study revealed that ZnO nanomaterial decomposes methyl orange as well as phenol red. The performance of ZnO nanoparticles indicates that it can be used as a photocatalyst for removal of organic contaminants present in water particularly in textile and chemical industries.
Polyaniline nanocomposite material have been synthesized by chemical precipitation method. Polymerization carried out of aniline in the presence of potassium peroxodisulphate in acidic medium which was then bind up with ferric ion in alkali medium. The PANI-Fe₃O₄ ferromagnetic nanocomposites have been characterized by FT-IR, UV-Vis and XRD techniques. The FTIR and UV-Vis results demonstrates the formation of polyaniline in the presence of Fe₃O₄ nanoparticles. XRD study shows that the particle size of all concentration of metal oxide with PANI lies in the range of 20-30 nm. Increase in the concentration of metal precursor to the oxidative polymerization of polyaniline has no effect on the particle size. But in the XRD pattern the basal plane was shifted to the higher theta value. This is may be due to small radius size of the nanoparticle which cause contraction in the unit cell parameters and hence decrease in lattice parameters. Morphology of the nanocomposite material has been studied using TEM. The TEM image clearly shows dispersion of metal oxide nanoparticle in the matrix of PANI chain. The particle size was shown to be 20-25 nm which is in good agreement with the XRD data.

Nanoparticles of Ni₀.₆Co₀.₄Fe₂O₄ have been synthesized by sol gel autocombustion method. The chemicals Fe(NO₃)₃.9H₂O, Ni(NO₃)₂.6H₂O, Co(NO₃)₂.6H₂O and citric acid were accurately weighed in desired stoichiometric proportions and dissolved separately in minimum amount of distilled water. The molar ratio of metal ion precursors to citric acid was kept 1:1. The individual solutions were then mixed together with constant stirring and the pH value of the solution was adjusted by adding ammonia solution. The solution was then slowly heated and stirred using a hot plate magnetic stirrer at 80°C till gel was formed which was ignited and burnt in a self-propagating combustion manner to obtain loose powder. The nanoferrite powders were prepared at various pH such as pH = 3, 7 & 11 annealed at 800°C in a muffle furnace for 2 hours. The average crystallite size of all ferrite samples was found to be in the range of 49.86 - 57.12 nm.

Thus the research work is carried out under this project is useful to the research workers in the field of nanocomposite materials based on metal oxide and will be great interest in their technological and scientific importance.